IMAGE PROCESSING FOR IMAGE CORRECTION

This application is based on application No. 11-183444 filed in Japan, the contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to image correction of digital image.

DESCRIPTION OF PRIOR ART

When digital image data received from a digital camera or the like are corrected, if a person is included in the image, the skin color has to be corrected accurately because skin color is a memory color. In prior art image processing, skin area or person area is extracted generally by using color information. For example, in the skin image recognition described in Japanese Patent laid open Publication 6-309433/1994, skin area candidates are searched from LHC data converted from RGB data, and a histogram on lightness is obtained. Then, an indication on closeness to skin is calculated from the histogram, and skin areas are determined based on the indication. In hand recognition described in Japanese Patent laid open Publication 7-

105371/1995, a skin pixel is detected in an image of hand when color components of the pixel are within a predetermined range, and a skin area is extracted in the image of hand. In skin area detection described in Japanese Patent laid open Publication 9-44670/1997, a histogram of hue converted from RGB data is obtained, and a face area is detected in a particular distribution range in the hue histogram. In person detection apparatus described in Japanese Patent laid open Publication 9-50528/1997, a face area is searched in RGB data, and a person area is divided to mosaics to extract a face area.

However, in the prior art image correction techniques, when skin color is extracted from the image and corrected, the image correction is performed on the entire image uniformly, and color correction is performed generally without limiting to skin. Therefore, when an image includes a plurality of persons having different skin characteristics, it is difficult to perform appropriate correction for each skin.

SUMMARY OF THE INVENTION

An object of the present invention is to provide appropriate image correction by taking each skin characteristic into account even when an image includes a plurality of persons having different skin characteristics.

Another object of the present invention is to provide image correction which can detect skin color fast in an image.

In one aspect of the invention, in the image processing

An advantage of the present invention is that even when an image includes a plurality of persons having different skin characteristics, correction appropriate for each skin type is possible.

Another advantage of the present invention is that skin areas can be extracted at high speed.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and features of the present invention will become clear from the following description taken in conjunction with the preferred embodiments thereof with reference to the accompanying drawings, and in which:

Fig. 1 is a diagram of an entire image processor;

Fig. 2 is a block diagram of a controller and thereabout;

Fig. 3 is a general flowchart of skin color correction;

Fig. 4 is a flowchart of skin color correction;

Fig. 5 is a diagram of an example of hue histogram concretely;

Fig. 6 is a diagram of an example of modification of the hue histogram;

Fig. 7 is a diagram of an example of chroma histogram;

Fig. 8 is a diagram of an example of modification of the chroma histogram; and

Fig. 9 is a diagram of an example of generation of correction curve.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, Fig. 1 shows an entire image processing apparatus according to a first embodiment of the invention. It has a controller (computer) 1 which controls the entire apparatus, as a central component. In Fig. 1, arrows show directions of data flow. A display device 2 displays various screens provided for operation or image processing as well as an image in a screen. A keyboard 3 and a mouse 4 are used for various inputs and instructions by a user. A flexible disk 5 and a hard disk 6 are storage media for storing, for example, image data, attribute information and programs. The apparatus has a flexible disk

drive and a hard disk drive for accessing the flexible disk 5 and the hard disk 6. A printer 7 prints image data or the like on a paper. A scanner 8 reads image data of a document. A CD-ROM 9 is a storage medium for storing various data or programs, and the apparatus has a CD-ROM drive for accessing the CD-ROM 9. Programs explained later are read from an external recording medium such as a CD-ROM.

Fig. 2 is a block diagram of the controller 1 and thereabout. The controller 1 has a central processing unit (CPU) 210 connected via a bus 220 to a read-only-memory (ROM) 203 for storing various programs and a random access memory (RAM) for storing various data and programs. Further, it is also connected via the bus 220 to a display controller 205 for displaying images and characters in a screen of the display apparatus 2, a keyboard controller 206 for controlling key-input from the keyboard 3, a mouse controller for controlling an input from the mouse 4, a flexible disk controller 208 which controls the flexible disk drive, a hard disk controller 209 for controlling the hard disk 6, a printer controller 210 which controls outputs to the printer 7, a scanner controller 211 which controls the scanner 8, and a CD-ROM drive controller 212 which controls the CD-ROM drive. Further, in the controller, a clock circuit 202 generates various clock signals for operating the apparatus. Further, extension slots 215 are

connected to the bus 220 for connecting various extension boards to which for example a SCSI board is connected for connecting a flexible disk drive, a hard disk drive, a scanner, a CD-ROM drive or the like. Further, it is also connected via an interface card to a network (web). In this apparatus, the flexible disk 5 and the hard disk 6 are used as storage media, but other medium such as a magneto-optical disk may also be used. The scanner 8 and the CD-ROM 9 are used for inputting image data, but another input devise such as a still video camera may also be used. The printer 7 is used as an output device, but a digital copying machine or the like may also be used.

In this apparatus, image data are corrected in an image correction routine which includes extraction and correction of skin color areas. When start of image correction is instructed by a user, the routine is evoked. The image correction routine further includes image file input/output processing, image data display processing, a graphic user interface processing for image correction operation, error processing in the graphic user interface processing, and resolution change processing, but they are not explained here.

In the image correction, even when an image includes a plurality of persons having different skin characteristics, skin is corrected by taking each skin

characteristic into account. Various types of skin areas have been classified beforehand for each skin characteristic. When image data are received, skin areas are extracted from the image data according to the skin type, and the image data are corrected appropriately by taking the skin characteristics of skin areas into account.

Table 1 compiles correction for each skin type wherein skin type is classified into white, yellow and tan. In the case of white, hue histogram is extended to shift center of gravity in a direction of skin color of memory color (pink), and chroma histogram is extended in a direction of standard chroma. In the case of yellow, hue histogram is extended to shift center of gravity in a direction of skin color of memory color, and chroma histogram is extended in a direction of high chroma. In the case of tan, hue histogram is extended to shift center of gravity in a direction of skin color of memory color (orange), and chroma histogram is extended in a direction of low chroma. As explained above, skin types are classified, and skin image is corrected according to the characteristic of skin type by modifying the histograms. Then, even when an image includes different skin types, each skin type can be corrected appropriately.

Table 1 Image correction according to skin type

Skin type	Correction	
	Hue	Chroma
White	Extend histogram to shift center of gravity in a direction of memory color (pink)	Shift center of gravity in a direction to standard chroma (center value of chroma), and extend histogram
Yellow	Extend histogram to shift center of gravity in a direction of memory color	Shift center of gravity in a direction to high chroma and extend histogram
Tan	Extend histogram to shift center of gravity in a direction of memory color (orange)	Shift center of gravity in a direction to low chroma and extend histogram

Fig. 3 shows a flowchart of skin correction in the image correction. First, skin color is extracted from input image data. The input image data is converted from RGB signals to HSL signals (step S10), and skin candidate areas are extracted roughly from the RGB signals of the input image data (step S12). Next, HSL signals in the extracted skin candidate areas are converted to Lab signals (stepS14), and skin areas are extracted carefully from data of ab (hue) (step S16). Because skin is extracted in the above-

mentioned two steps, skin areas can be extracted together from the image at high precision and at high speed, and the image extraction has no dropping out on skin area.

Next, skin is corrected. First, histograms of hue and chroma are prepared for each of the extracted skin areas (step S18). Next, an average, a dispersion and a center of gravity are calculated from the histograms and skin characteristic is classified based thereon (step S20), and the forms of histograms are modified (step S22). Next, a correction curve for correcting input data to generate output data is determined according to the adjusted histograms (step S24), and the skin color is corrected by using the correction curve (step S26).

Fig. 4 shows a flow chart of skin correction concretely. First, image data (RGB signals) are received (step S100), and the image data are divided into rectangles (or a mosaic image) (step S102). Next, the input RGB signals are converted to HSL signals (step S104).

Next, skin color is extracted from the image data. First, skin candidate areas are extracted coarsely from hue (H) signals for each rectangle (Step S106). In this extraction, a range of hue to be detected is limited, so as to detect generally all types of skin. However, skin type cannot be specified. Next, HSL signals are converted to Lab signals only on the extracted skin candidate areas (step

S108). Next, the skin candidate areas are extracted finely according to the a, b signals for each rectangle (step S110). That is, skin type is specified from the signals ab to extract skin candidate areas. In this skin extraction, in the first step, the processing is simple and coarse, and in the second step, the processing is heavy but fine. Then, the extraction can be performed at high speed. Next, the images are divided into skin areas (step S112), wherein the skin candidate areas obtained in the unit of rectangle are integrated for each skin type specified above. In the integration, a differences of the a, b signal is compared between adjacent rectangles and compared with a threshold determined for skin type, and if the a, b signals are within the thresholds, the adjacent rectangles are integrated.

Next, skin is corrected. First, histograms of hue and chroma are prepared for each of the skin areas which have been extracted and integrated above (step S114). Next, in order to determine the skin characteristic, an average, a dispersion and center of gravity are calculated from the histograms (step S116). Next, processing shown in Table 1 is performed for each area. First, skin type is classified (step S120). Then, the histogram of hue is extended to shift the center of gravity in a direction of skin color of memory color according to the skin type, and the histogram of chroma is extended in a direction according to the skin

type, based on the average, dispersion and center of gravity of the histograms (step S122). Next, correction curves are determined on hue and chroma (step S124), and skin image is corrected by using the correction curves (step S126). Next, it is decided whether a next area to be processed is remained (step S128). If there is a next area, the flow returns to step S116, and the above skin correction is repeated. If there is no next area, the processing is completed.

An example of the processing on the histogram of hue is explained with reference to Figs. 5 and 6. Fig. 5 shows a histogram of hue in a skin area. In the histogram, center of gravity is shifted from "A" (white circle) to "B" (black circle) of memory color of skin color according to skin type, and as shown in Fig. 6, the width "a" is increased to "b".

Fig. 7 shows a histogram of chroma for skin type of white in a skin area. As shown in Fig. 8, the histogram is subjected to the correction explained above with reference to Table 1, wherein the center of gravity is shifted in a direction of standard chroma (center of chroma) and the histogram is extended.

With reference to the modification of the histogram, as shown in Fig. 9, a correction curve for correcting input data to output data is determined (as

explained on step S124). The correction curve is prepared by accumulating the frequencies of the histogram of chroma from the low level to high level.

Although the present invention has been fully described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. Such changes and modifications are to be understood as included within the scope of the present invention as defined by the appended claims unless they depart therefrom.